AD-A192 984 AUTOMATIC LINE NETWORK EXTRACTION FROM AERIAL IMAGERY 1/1
OF URBAN AREAS THRO..(U) FORSCHUNGSINSTITUT FUER
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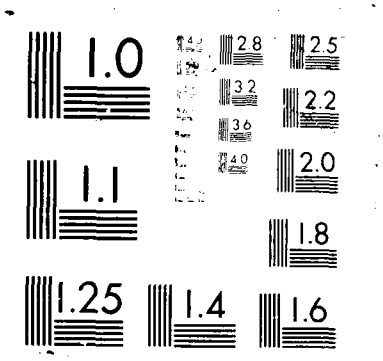
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AUTOMATIC LINE NETWORK EXTRACTION FROM AERIAL IMAGERY OF URBAN AREAS THROUGH KNOWLEDGE-BASED IMAGE ANALYSIS

AD-A192 984

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Third Interim Report

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1. Present Status

During the past three months work has been concentrated on two topics, namely the implementation of a framework that allows the integration and test of the system components, and the implementation of low level processing methods. These activities are explained to some detail in the following.

1.1 Framework for Integration and Test of the System

Knowledge-based image analysis systems operating on natural images tend to be large software systems, consisting of a multitude of different software components. Due to the wide range of processes involved in such systems, as well as the diversity of iconic (image-like) and symbolic data structures, a transparent and modular system structure and clear definitions of the emerging interfaces are indispensable for the successful realization of such systems.

Therefore, we introduce software engineering methods and some standardizations in software development in order to keep the overall system development under control. During the past three months we have implemented a framework that allows the flexible test of all system components as well as the investigation of the dynamic behaviour of these components. A less elaborated version of the framework was used successfully in a previous project. The enhanced version of the framework permits the simultaneous development, test, and maintenance of software components by a team of programmers. Now it is very easy to integrate new or already existing software modules into the system, provided that some standards are met.

1.2 Low Level Processing Methods

Parallel to the implementation of the framework we have begun with the implementation of low level processing methods. Here we use in part methods which have already been developed in the context of other projects. Nevertheless adaptation and enhancement of existing methods as well as the development of additional methods are necessary.

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Following the observation that objects often can be more easily recognized in images of a low resolution (this is due to the fact that confusing details in the high resolution images are not present in the low resolution ones), we compute first a gray-level pyramidal structure of the image. The gray-level pyramid of the image is computed in a straightforward manner, partitioning the digitized image into nonoverlapping patches of a size of 2*2 pixels each. The patches are replaced by the average pixel densities (gray-levels) and constitute the next (lower) resolution level of the gray-level pyramid. The averaging has the effect of attenuating the higher frequencies in the frequency domain. Hence the fine details in the higher resolution levels of the pyramid are reduced, which leads in turn to a better recognition of the objects.

In the next processing step simple feature detectors are applied to all levels of the gray-level pyramid. The used detectors are a spot detector, a line detector, and an edge detector. Applying each feature detector to each level of the gray-level pyramid leads to three pairs of feature pyramids. The first pair of the pyramids contains dark and bright contrasting spots (the first pyramid of the pair contains the contrast response, the second pyramid the surroundedness response of the spot detector). The second pair of the pyramids contains dark and bright contrasting line elements (the first pyramid refers to the contrast of line elements, the second pyramid refers to the direction of line elements). The last pair of pyramids contains the edge elements (contrast, and direction).

Projection of the spots from a lower resolution level of the spot pyramid to a higher resolution level, and binarization with the meanvalue of the projected spots in a suitably chosen neighborhood leads to the segmentation of homogeneous image segments (dark and bright contrasting area-like segments with a homogeneous gray-level). Tracking of compatible (contrast and direction) line elements, resp. edge elements leads to dark and bright contrasting line segments, resp. edge segments. To enhance segmentation results of noisy images, relaxation techniques can be applied optionally to the line, resp. edge elements prior to the

tracking procedures.

The application of the feature detectors leads to a first, initial segmentation of the input image. The resulting segments (areas, lines, and edges) are provided with confidence values and after computing additional features, stored iconically as well as symbolically in appropriate data bases of the system.

Fig. 1 gives an overview of the low level processing methods of the system, described above.

Image segmentation by different methods can be regarded as obtaining results from competing knowledge-sources or experts (an expert for spot detection, an expert for edge detection and so on). Because different experts have a different view of the image function, it stands to reason that at certain locations of the image the answers of the experts may be contradictory. Goal of subsequent reasoning processes is to decide, which knowledge-source(s) or expert(s) describe the image function correct in the sense of a consistent line network extraction of the image, but this is a topic for one of the next reports.

2. Continuation of Work

Next topic to be done is to finish the implementation of the segmentation procedures and to store the initial segmentation results in appropiate data bases of the system. Another topic to be done is to elaborate a control mechanism for the automatic invocation of image processing procedures, depending on the actual state of image analysis.

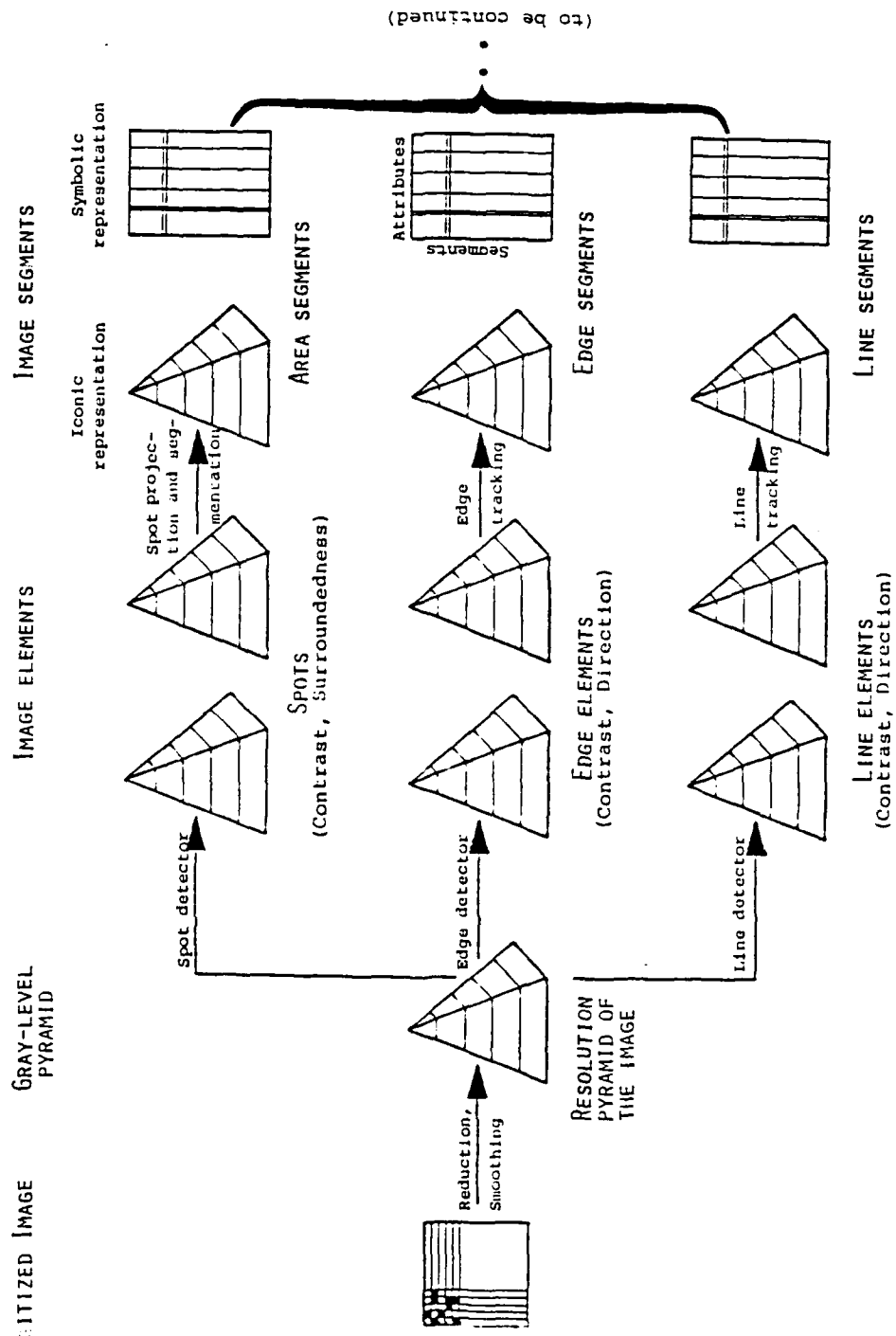

Fig. 1: Low level processing methods
(for a detailed description see text)

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